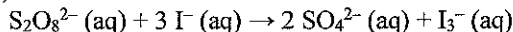


## RATE LAWS WORKSHEET I

1. Using the experimental data provided, determine the order of reaction with respect to each reactant, write the rate law, determine the overall order of the reaction, and calculate the rate law constant, k.



Experiment	Initial Concentration (mol/L)		Initial Rate (mol/L·s)
	$\text{S}_2\text{O}_8^{2-}$	$\text{I}^-$	
1	0.15	0.21	1.14
2	0.22	0.21	1.70
3	0.22	0.12	0.98

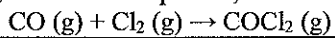
$\text{S}_2\text{O}_8^{2-}$  2<sup>nd</sup> order  
 $\text{I}^-$  1<sup>st</sup> order

Rate =  $k[\text{S}_2\text{O}_8^{2-}][\text{I}^-]$  ← Rate Law

$1.14 = k(0.15)(0.21)$

$k = 36.2 \text{ L/mol}\cdot\text{s}$  ← Rate Law Constant.

2. Using the experimental data provided, determine the order of reaction with respect to each reactant, the rate law equation, the overall order of reaction, and calculate the rate law constant, k.



Experiment	Initial Concentration (mol/L)		Initial Rate (mol/L·s)
	CO	$\text{Cl}_2$	
1	0.12	0.20	0.121
2	0.24	0.20	0.241
3	0.12	0.40	0.483

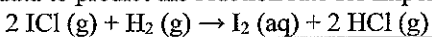
CO - 1<sup>st</sup> order  
 $\text{Cl}_2$  - 2<sup>nd</sup> order

Rate =  $k[\text{CO}][\text{Cl}_2]^2$

$0.121 = k(0.12)(0.20)^2$

$k = 25.2 \text{ L}^2/\text{mol}^2\cdot\text{s}$

3. Using the experimental data provided, determine the order of reaction with respect to each reactant, the rate law equation, the overall order of reaction, and calculate the rate law constant, k. Use the data to predict the reaction rate for Experiment 4.



Experiment	Initial Concentration (mol/L)		Initial Rate (mol/L·s)
	ICl	$\text{H}_2$	
1	1.5	1.5	$3.7 \times 10^{-7}$
2	3.0	1.5	$7.4 \times 10^{-7}$
3	3.0	4.5	$2.2 \times 10^{-6}$
4	4.7	2.7	?

ICl - 1<sup>st</sup> order  
 $\text{H}_2$  - 1<sup>st</sup> order

Rate =  $k[\text{ICl}][\text{H}_2]$

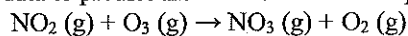
$3.7 \times 10^{-7} = k(1.5)(1.5)$

$k = 1.64 \times 10^{-4} \text{ L/mol}\cdot\text{s}$

Rate =  $(1.64 \times 10^{-4})(4.7)(2.7)$

Rate =  $2.1 \times 10^{-6} \text{ mol/L}\cdot\text{s}$

4. Using the experimental data provided, determine the order of reaction with respect to each reactant, the rate law equation, the overall order of reaction, and calculate the rate law constant,  $k$ . Use the data to predict the reaction rate for Experiment 4.



Experiment	Initial Concentration (mol/L)		Initial Rate (mol/L·s)
	NO <sub>2</sub>	O <sub>3</sub>	
1	0.21	0.70	6.3
2	0.21	1.39	12.5
3	0.38	0.70	11.4
4	0.66	0.18	?

NO<sub>2</sub> - 1<sup>st</sup> order  
O<sub>3</sub> - 1<sup>st</sup> order

$$\text{Rate} = k[\text{NO}_2][\text{O}_3]$$

$$6.3 = k(0.21)(0.70)$$

$$k = 42.9 \text{ L/mol}\cdot\text{s}$$

$$\text{Rate} = 42.9(0.66)(0.18)$$

$$\text{Rate} = 5.09 \text{ mol/L}\cdot\text{s}$$

5. The reduction of bromate ions, BrO<sub>3</sub><sup>-</sup>, by bromide ions in acidic solution has a rate law

$$R = k[\text{BrO}_3^-][\text{Br}^-][\text{H}^+]^2$$

- a. What are the orders with respect to the reactants?  
b. What is the overall order?

$$\left. \begin{array}{l} \text{BrO}_3^- - 1^{\text{st}} \text{ order} \\ \text{Br}^- - 1^{\text{st}} \text{ order} \\ \text{H}^+ - 2^{\text{nd}} \text{ order} \end{array} \right\} \begin{array}{l} \text{Overall} \\ 4^{\text{th}} \text{ order} \end{array}$$

6. The reaction between bromomethane and hydroxide ion in aqueous solution is first order with respect to bromomethane, and second order overall. Write the rate law.

$$\text{Rate} = k[\text{CH}_3\text{Br}][\text{OH}^-]^2$$

↑  
formula for  
bromomethane  
(you will learn  
about this later)